Near-field thermal radiation in many-body nanosystems with the discrete dipole approximation

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When two or more particles are separated by distances smaller than the characteristic thermal wavelength, the radiation exchange is said to be in the "near-field" regime and may exceed the blackbody limit by several orders of magnitude [1]. Several variations on the discrete dipole approximation (DDA), a well-known numerically exact method for calculating scattering by small particles [2], have recently been applied to predict near-field thermal emission and radiation heat transfer among particles [3–5]. If they are spheroidal, smaller than the characteristic wavelength, and separated by a distance greater than the effective radius, the particles may be represented as point dipoles and the radiation exchange is solved exactly with the many-body radiative transfer theory [3,4]. When these conditions are not met, the particles may be discretized into subvolumes to calculate the radiative heat transfer [5]. However, the stochastic nature of the interaction matrices when thermal sources are used imposes limitations on solution methodologies typically used with the DDA, which creates computational challenges for large particles, small separation distances, or many particles.

In this talk we review the application of the DDA to near-field thermal radiation among small particles, and we summarize solution methodologies and limitations for different size and separation distance regimes. We describe notable results for each case, and we discuss options moving forward to achieve computationally efficient solutions for near-field thermal radiation in many-body nanosystems.

References

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